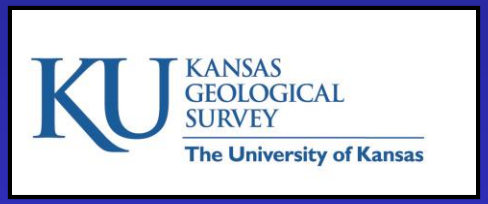
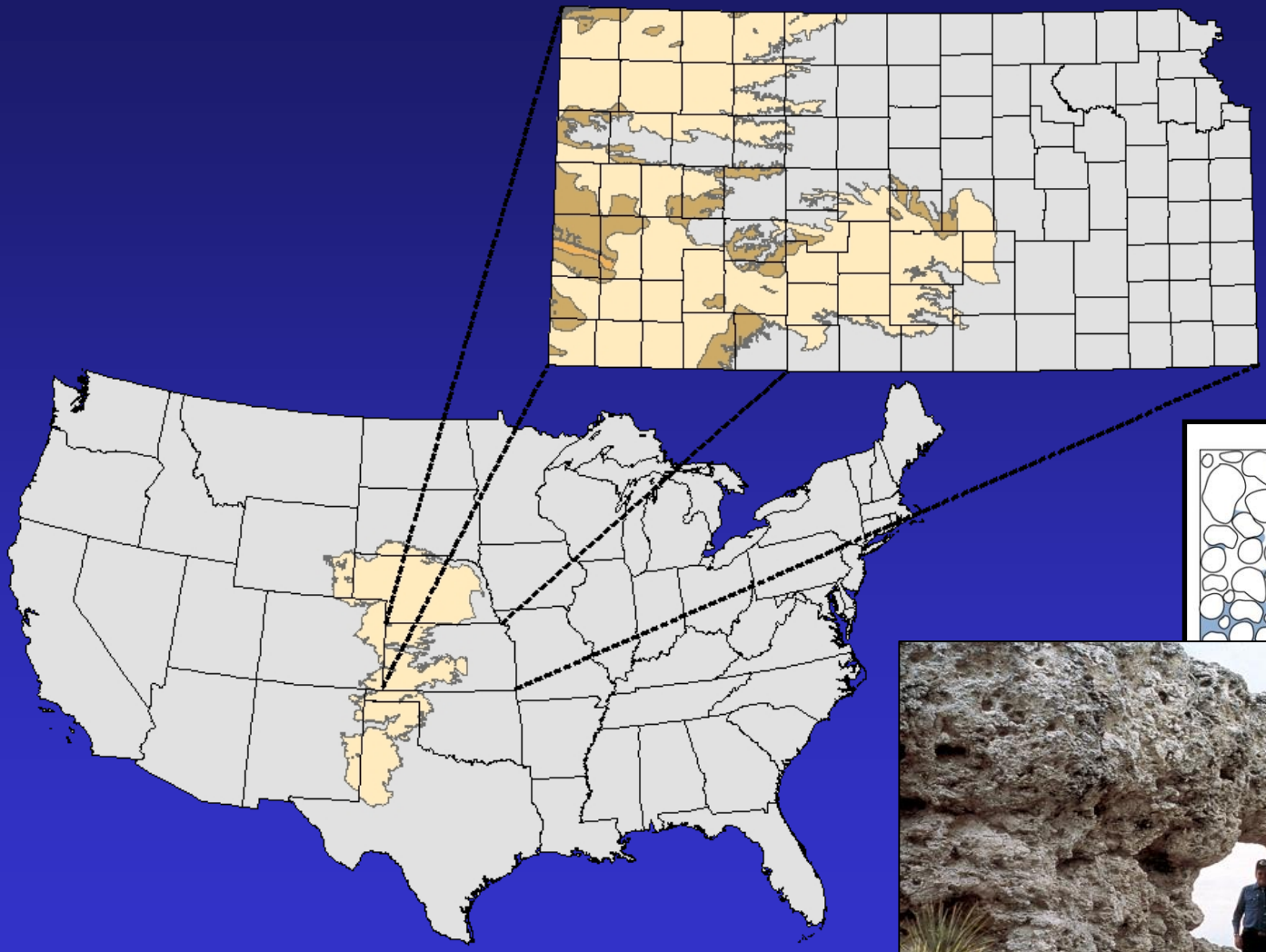
Using GIS Tainted Glasses to Help Subdivide the Ogallala/High Plains Aquifer

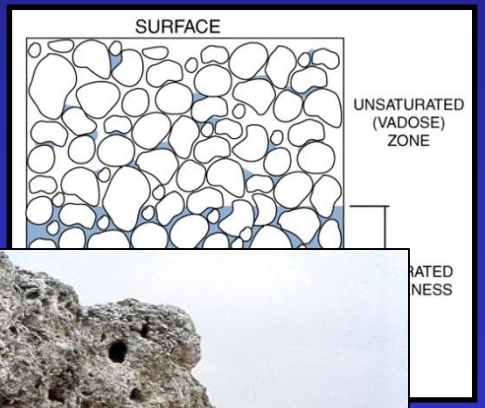
12th Annual GIS Day @ KU
November 20, 2013



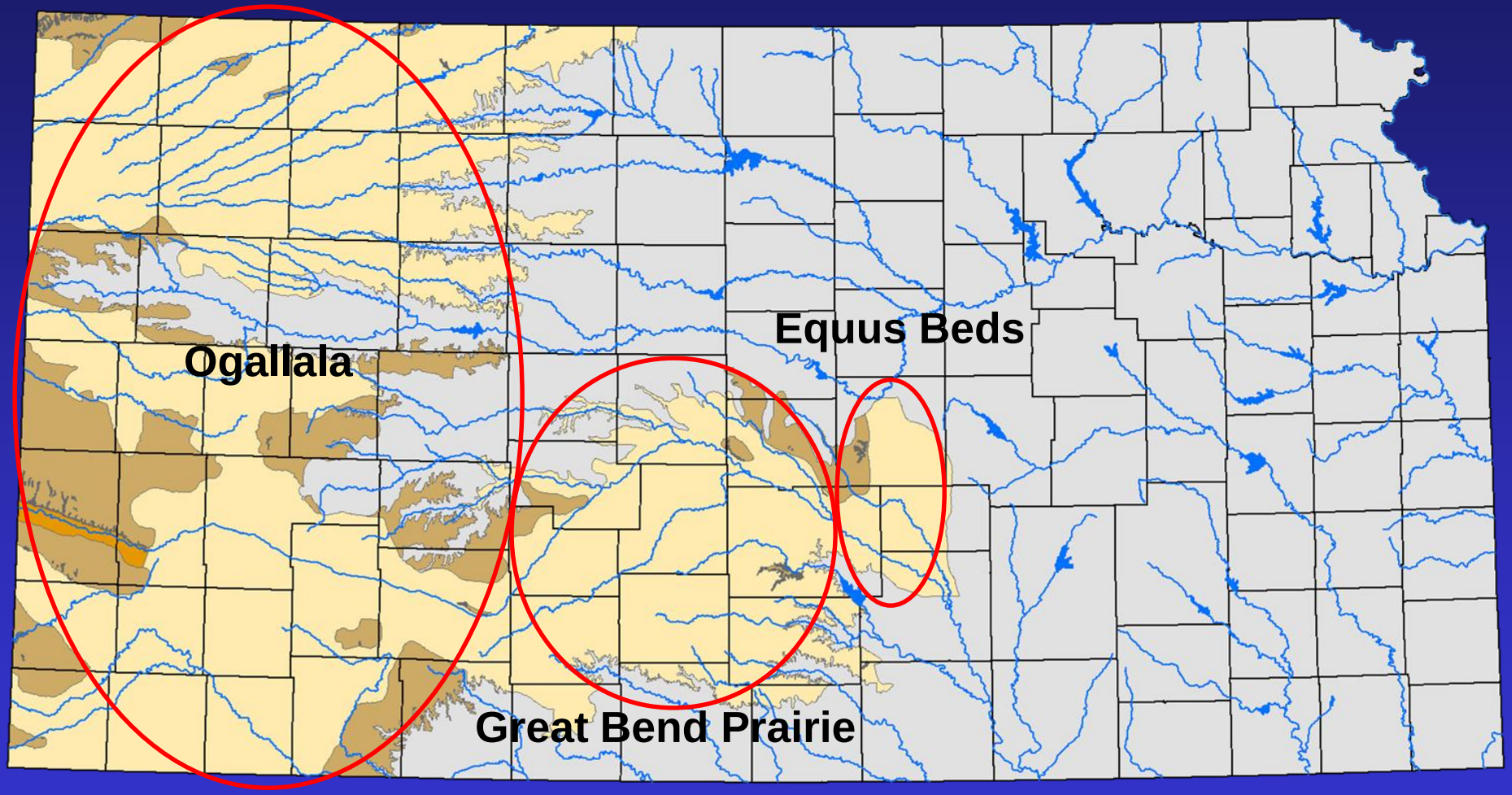
Brownie Wilson
Geohydrology Section
Kansas Geological Survey
University of Kansas

The High Plains Aquifer

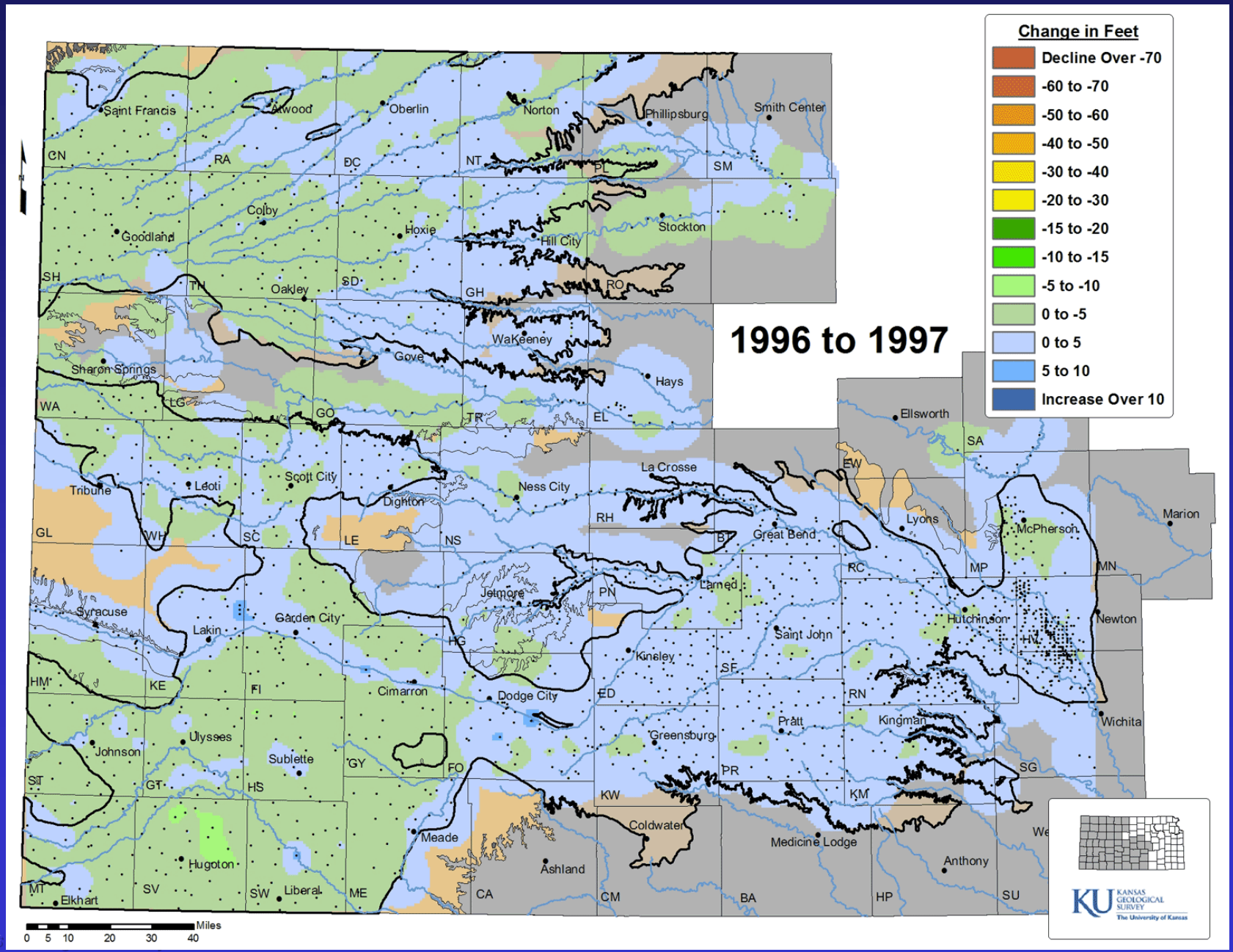




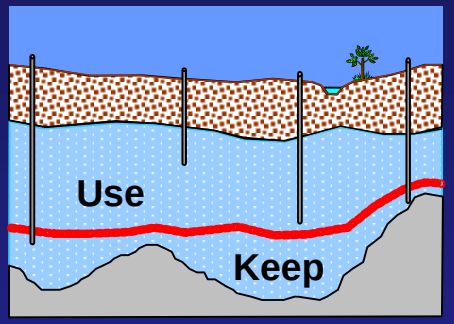
The High Plains Aquifer in Kansas



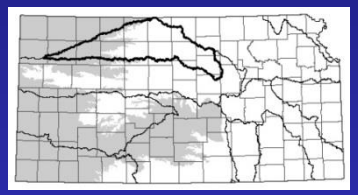
Accumulated Water Level Change, 1996 to 2012



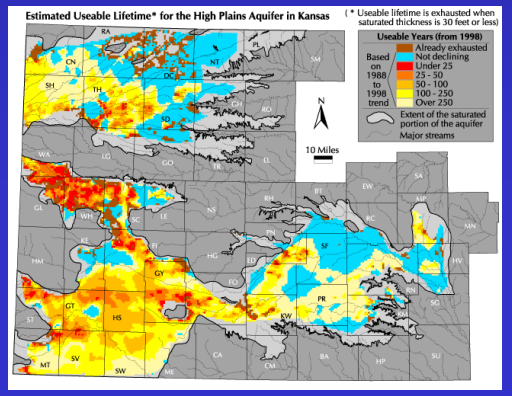
Water Management Activities, circa 2000



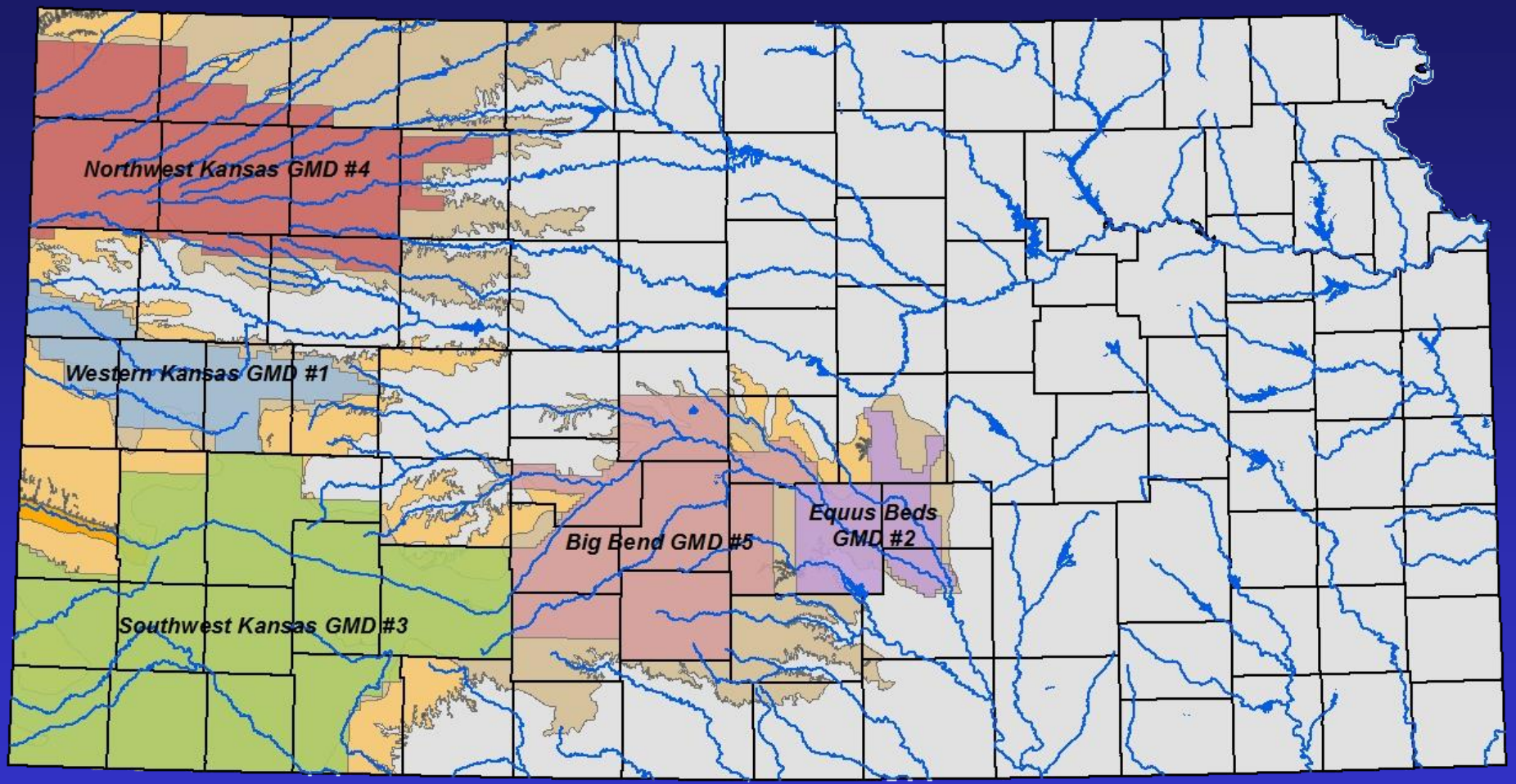
- Active discussions on the Ogallala Aquifer
  - Management and Technical Committees
  - Ogallala Two-Pool Concept
- Solomon Basin Advisory Committee Calls for Sustainability
- Governor Graves Call for Non-Depletion of Aquifers



- House Substitute for Senate Bill 287
  - Potential for Competing Water Needs for the Next 20 Years
  - Aquifer Resources and Transitions to Sustainability
    - KGS High Plains Aquifer Atlas
- Kansas Water Plan- Establish Aquifer Subunits across the Ogallala portion of the High Plains aquifer
- Apply Unique Management Plans

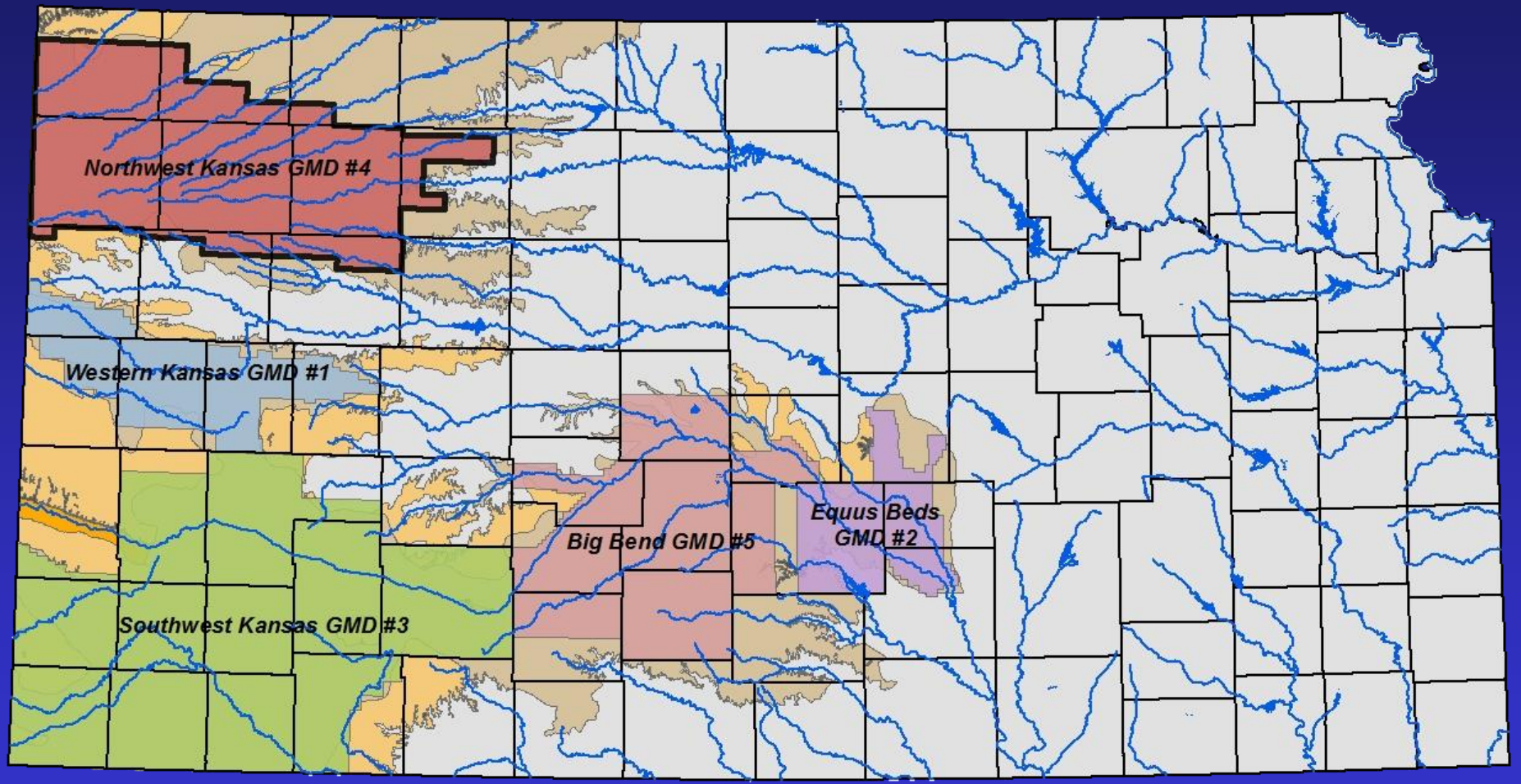


Groundwater Management Districts in Kansas

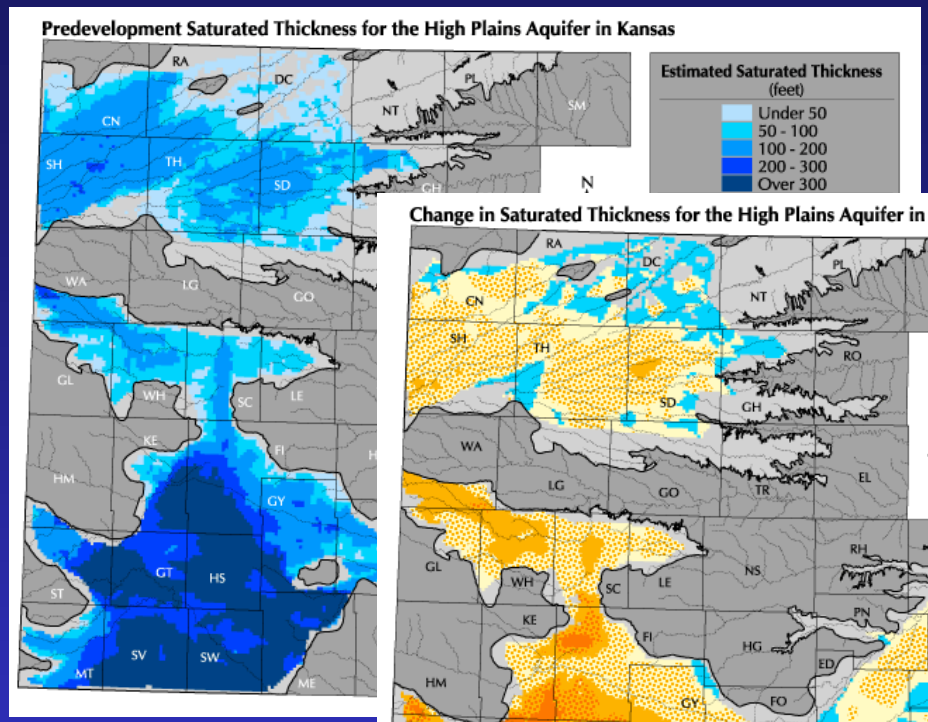


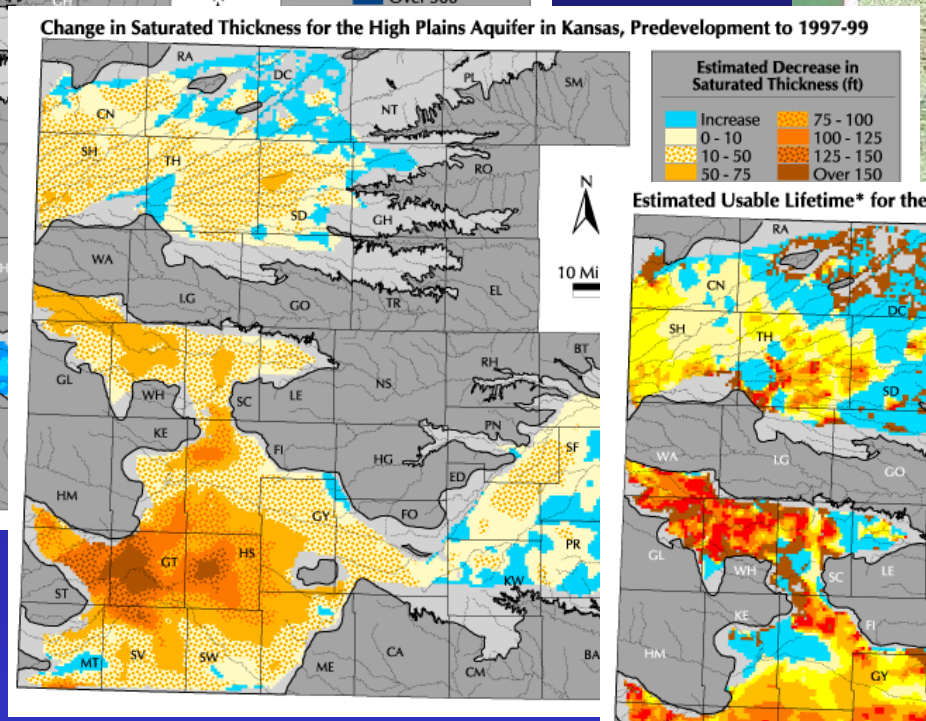
Kansas Water Plan directed the KGS to provide technical assistance to the western GMDs with aquifer subunits delineation

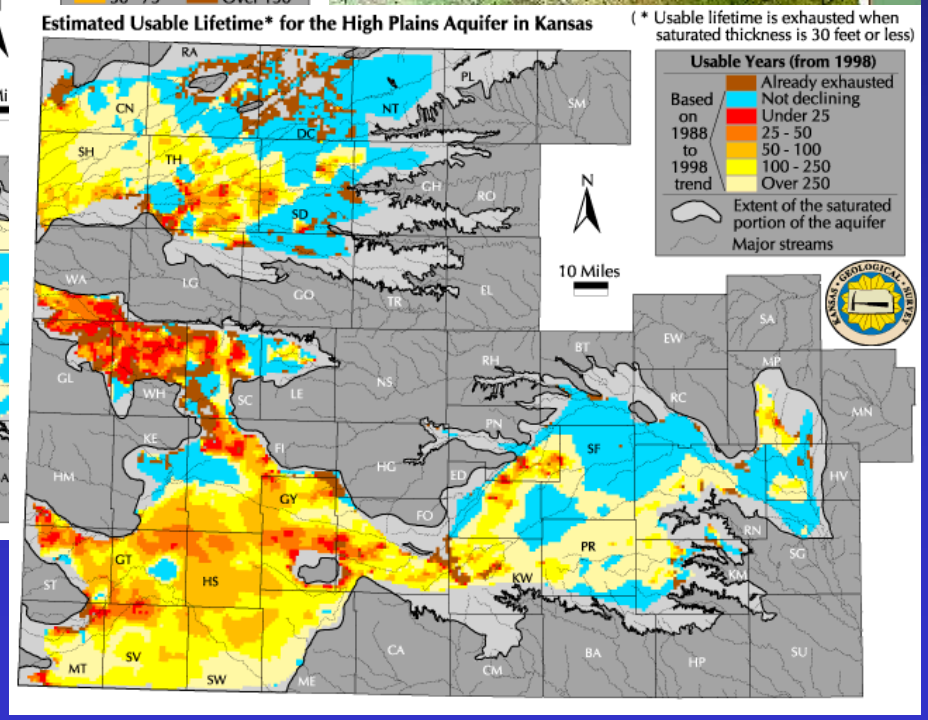
Northwest Kansas GMD #4



Kansas High Plains Aquifer Atlas



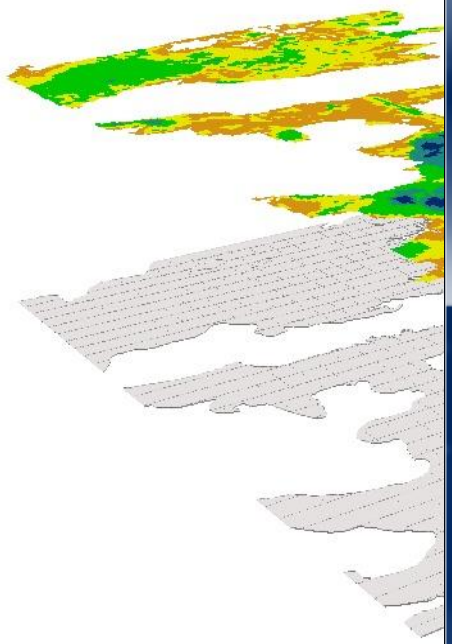




http://www.kgs.ku.edu/HighPlains/HPA_Atlas/index.html

High Plains Section-Level Database

Values from interpolate



are assi

Select Variables - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Select Variables

hercules.kgs.ku.edu/geohydro/section_data/hp_step2.cfm?RequestTimeout=1000

Kansas Geological Survey | Hydrology | Wizard Water Well Query | High Plains Home

High Plains Aquifer Section-Level Database

(click here for more information about the database and clustering tool)

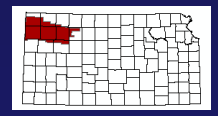
Select Variables

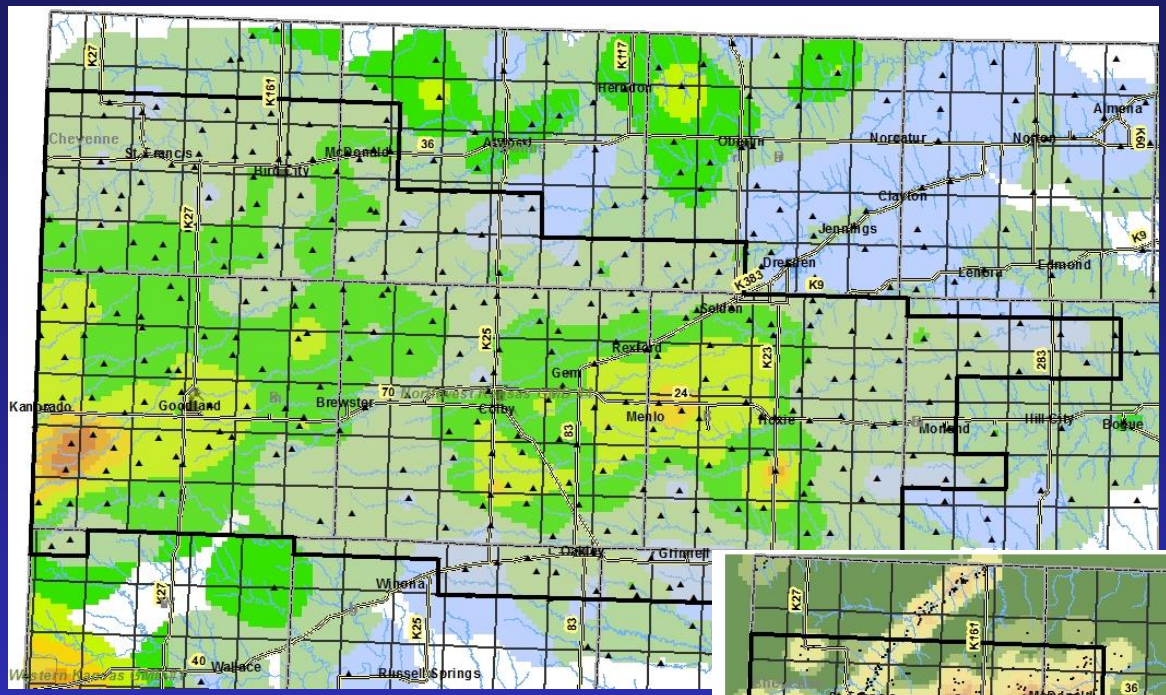
Variable	Column Name	Scale	Select
Geographic			
Section center Longitude	LONGITUDE	S	
Section center Latitude	LATITUDE	S	
Groundwater Management District Number (fringe areas contain extra "1")	GMD	S	
Hydrogeology and Aquifer Characteristics			
Bedrock elevation (ft)	BDRK_ELEV	T-	
Hydraulic conductivity (ft/day)	HYDR_COND	T-	
Specific yield	SPEC_YLD	T-	
Distance in meters to alluvial deposits (0 indicates alluvium within section)	DISTANCE_TO_ALLUVIUM	S+	
Water Budget Variables			
USGS Potential Annual Recharge (in)	USGS_RECHARGE	T+	
Land Surface Elevation at the section center (ft)	LSE	S	
Depth to water, 1998 (3 year avg in ft)	DTW_98	T	
Depth to water, 2001 (3 year avg in ft)	DTW_2001	T	
Depth to water, 2004 (2 year avg in ft- rwb selection)	DTW_2004_RWB	T	
Water level elevation, predevelopment (ft)	WLE_PRE	T+	
Water level elevation, 1998 (3 year avg in ft)	WLE_98	T	
Water level elevation, 2001 (3 year avg in ft)	WLE_2001	T	
Water level elevation, 2004 (2 year avg in ft- rwb selection)	WLE_2004_RWB	T	
Water level elevation, 1996 (3 year avg in ft- g4 selection)	WLE_1996_G4	T	
Water level elevation, 2002 (3 year avg in ft- g4 selection)	WLE_2002_G4	T	
Saturated thickness, predevelopment (ft)	ST_PRE	T+	
Saturated thickness, 1998 (3 year avg in ft)	ST_98	T	
Saturated Thickness, 2001 (3 year avg in ft)	ST_2001	T	
Saturated Thickness, 1996 (3 year avg in ft- g4 selection)	ST_1996_G4	T	

hp_section_data

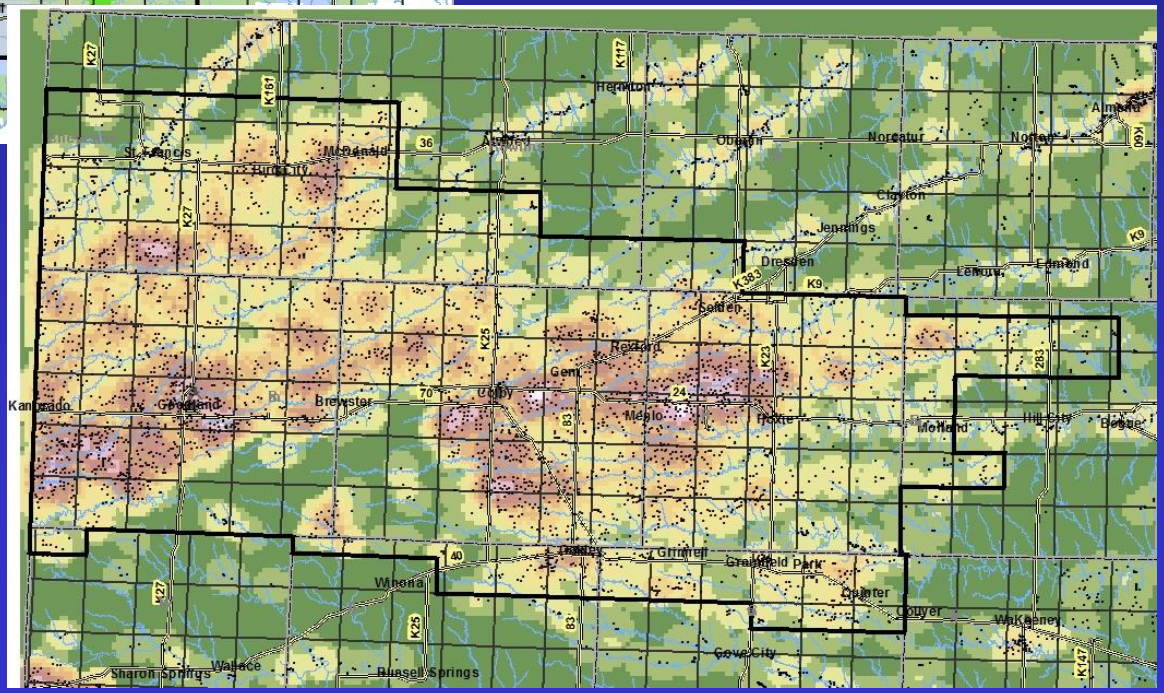
TRS	LSE	HYDR_COND	W	olume
35S34W12	2881.91	18		59.16
34S42W35	3505.34	27		28.85
34S37W29	3157.82	95		45.87
34S32W22	2745.1	33		59.33
34S42W36	3492.94	24		29.58
34S37W28	3140	100		49.21
34S41W31	3485.62	24		31.13
34S37W27	3128.37	105		49.85

Northwest Kansas GMD #4 Subunit Criteria



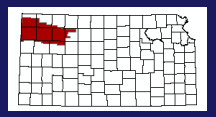


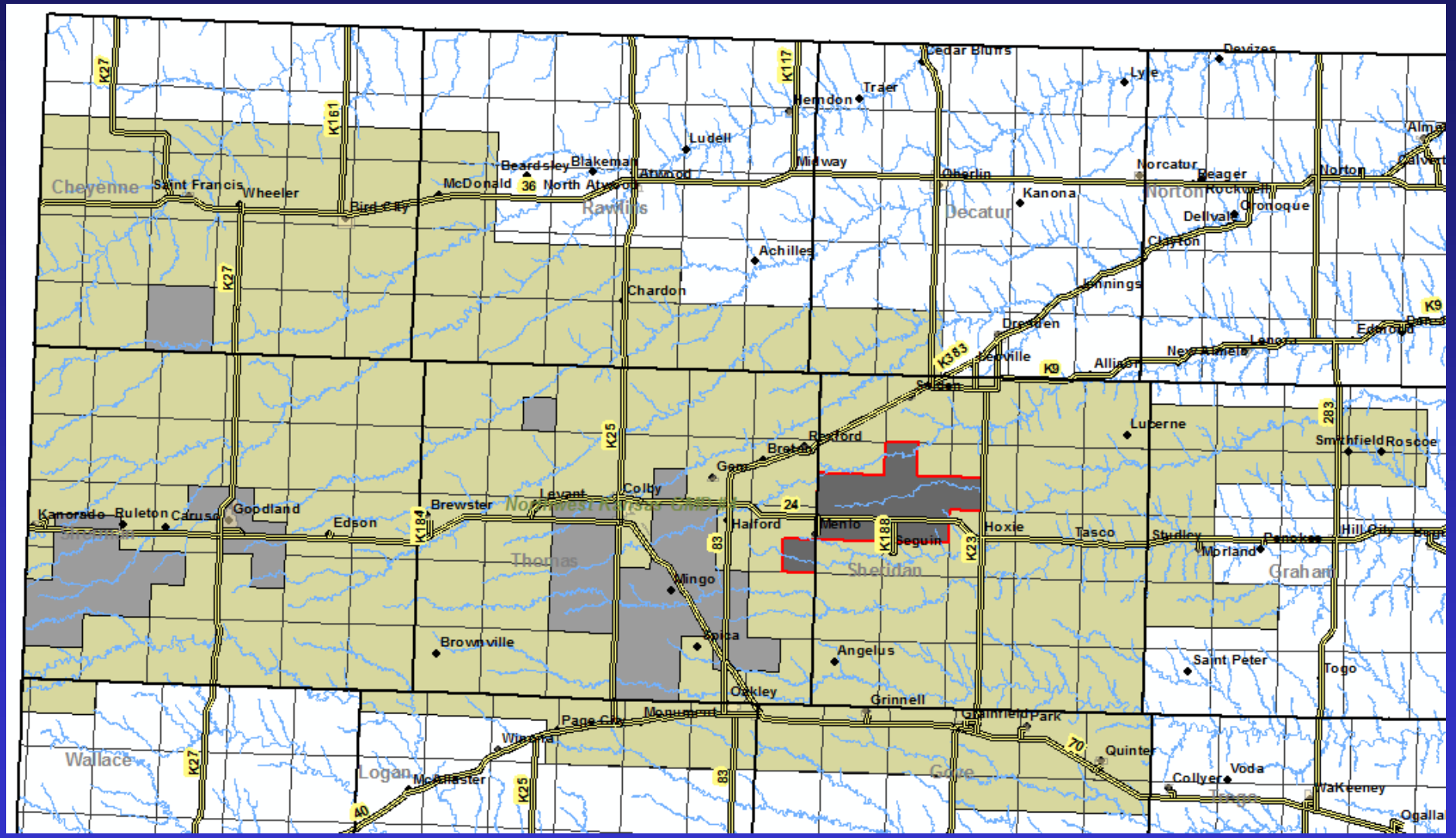
Water Level Change



Water Usage

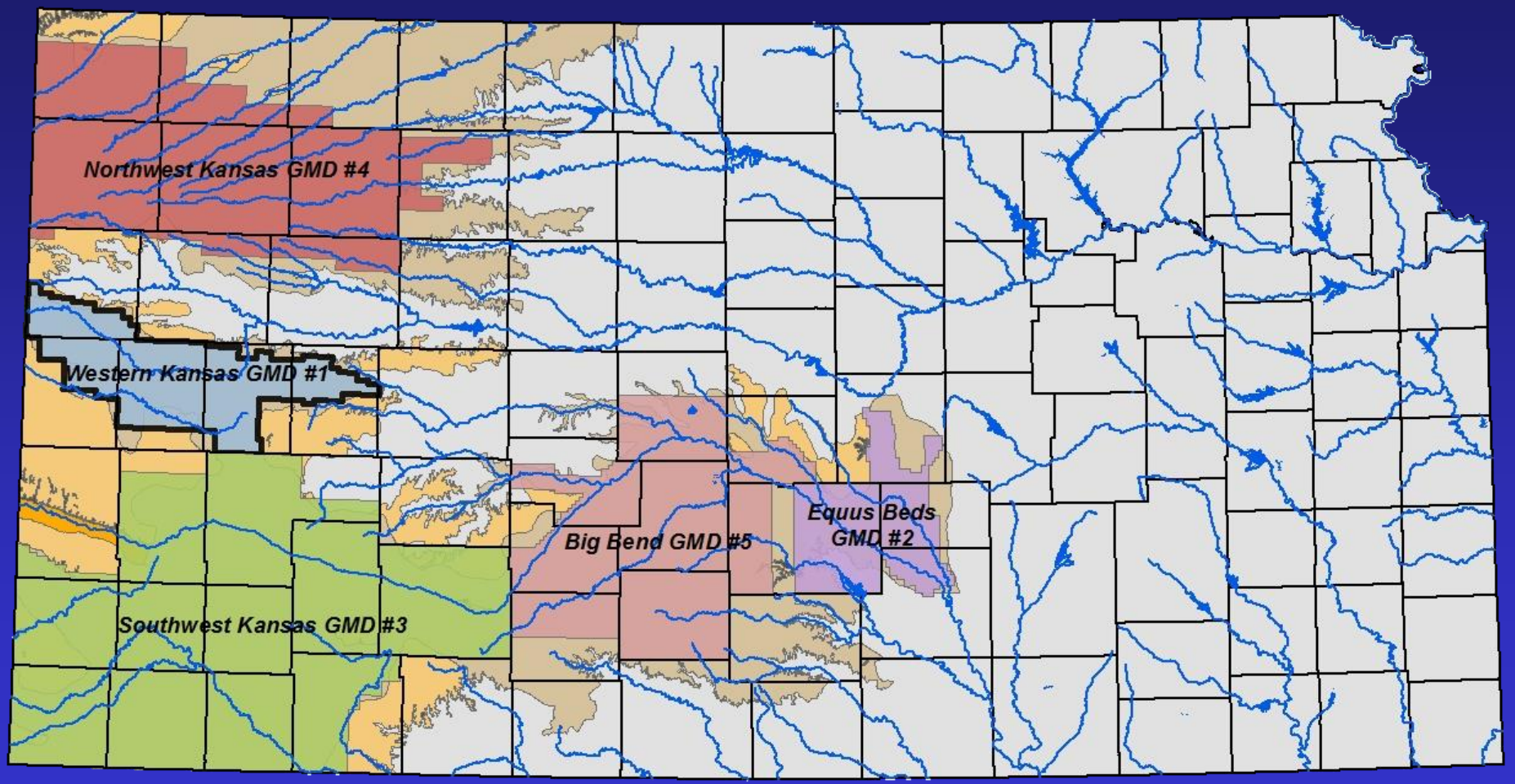
GMD4 Aquifer Subunits / Priority Areas



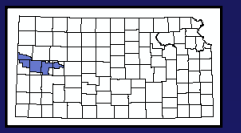


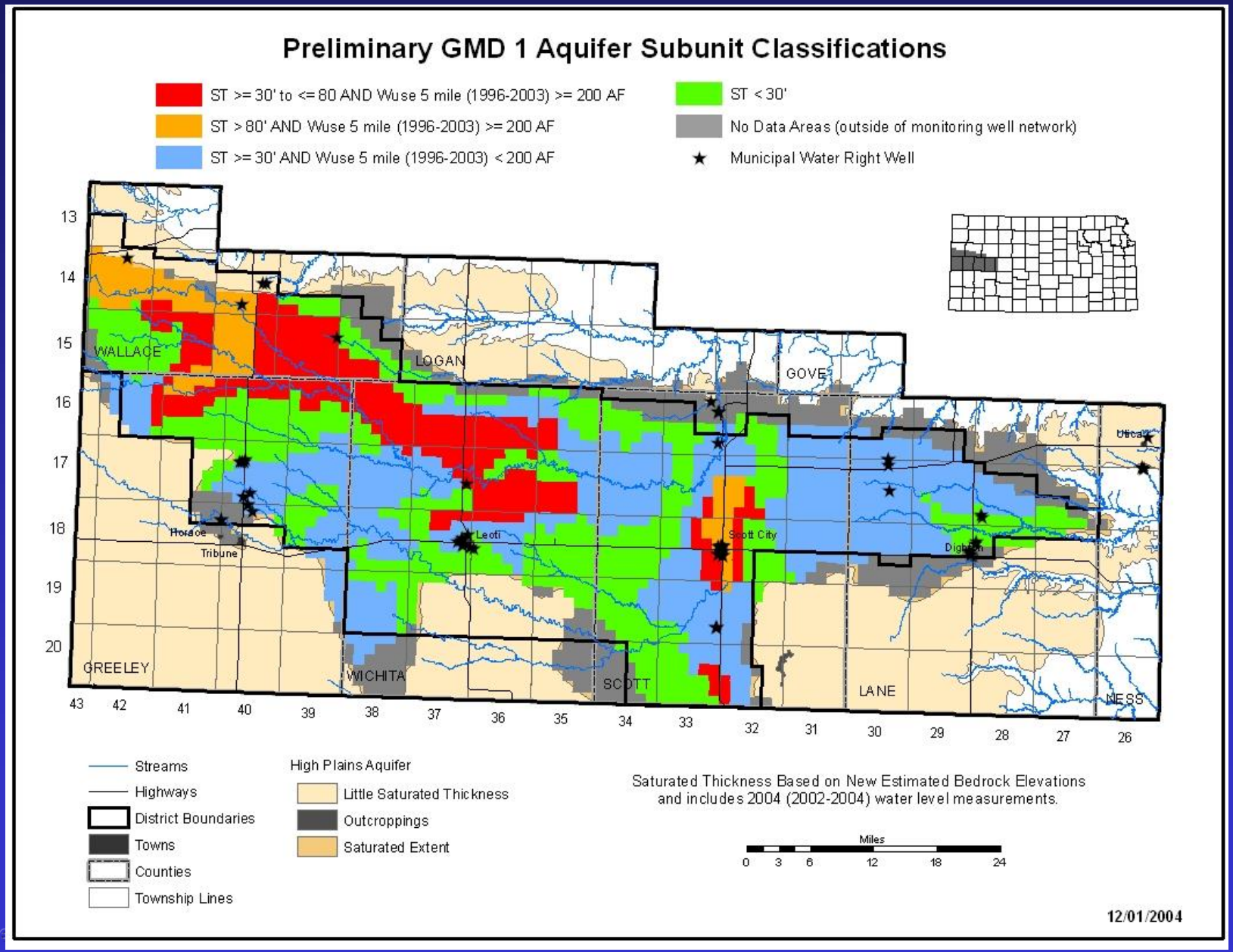
SD 6 Local Enhanced Management Areas (LEMA)

Western Kansas GMD #1

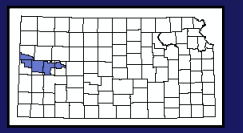


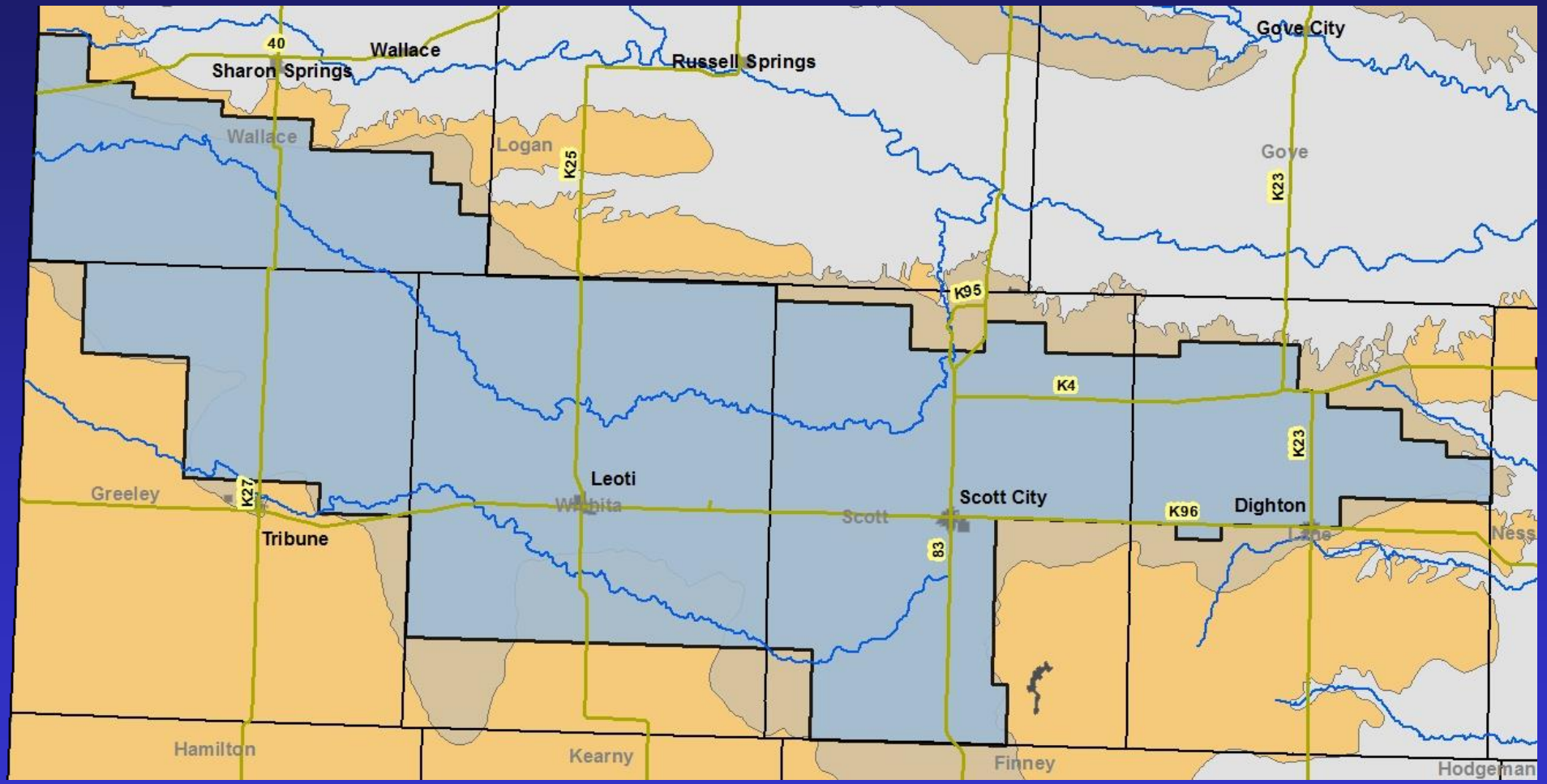
Western Kansas GMD #1 Subunit Criteria



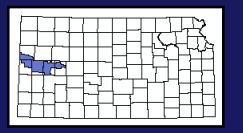


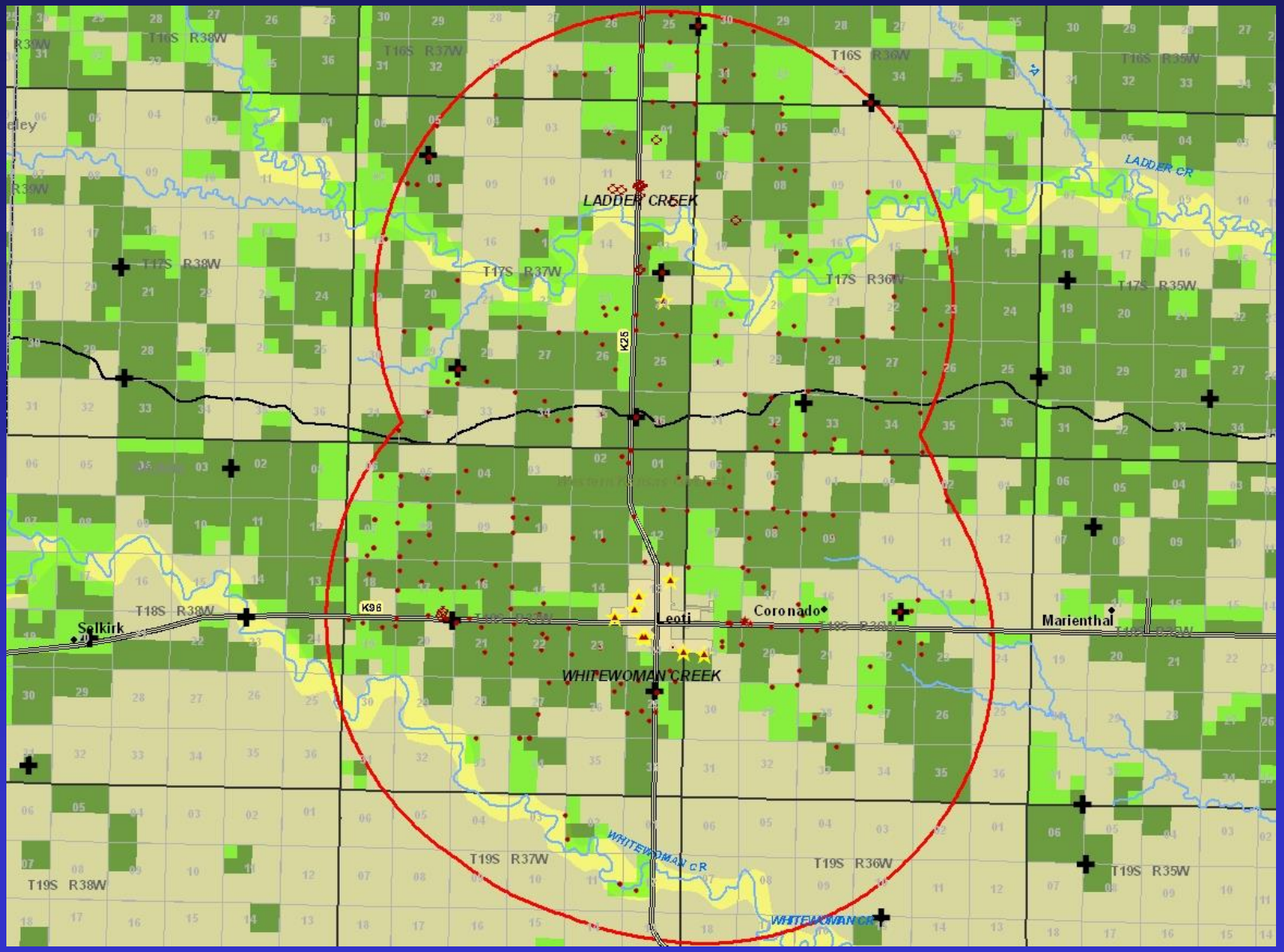
Western Kansas GMD #1 Subunit Criteria



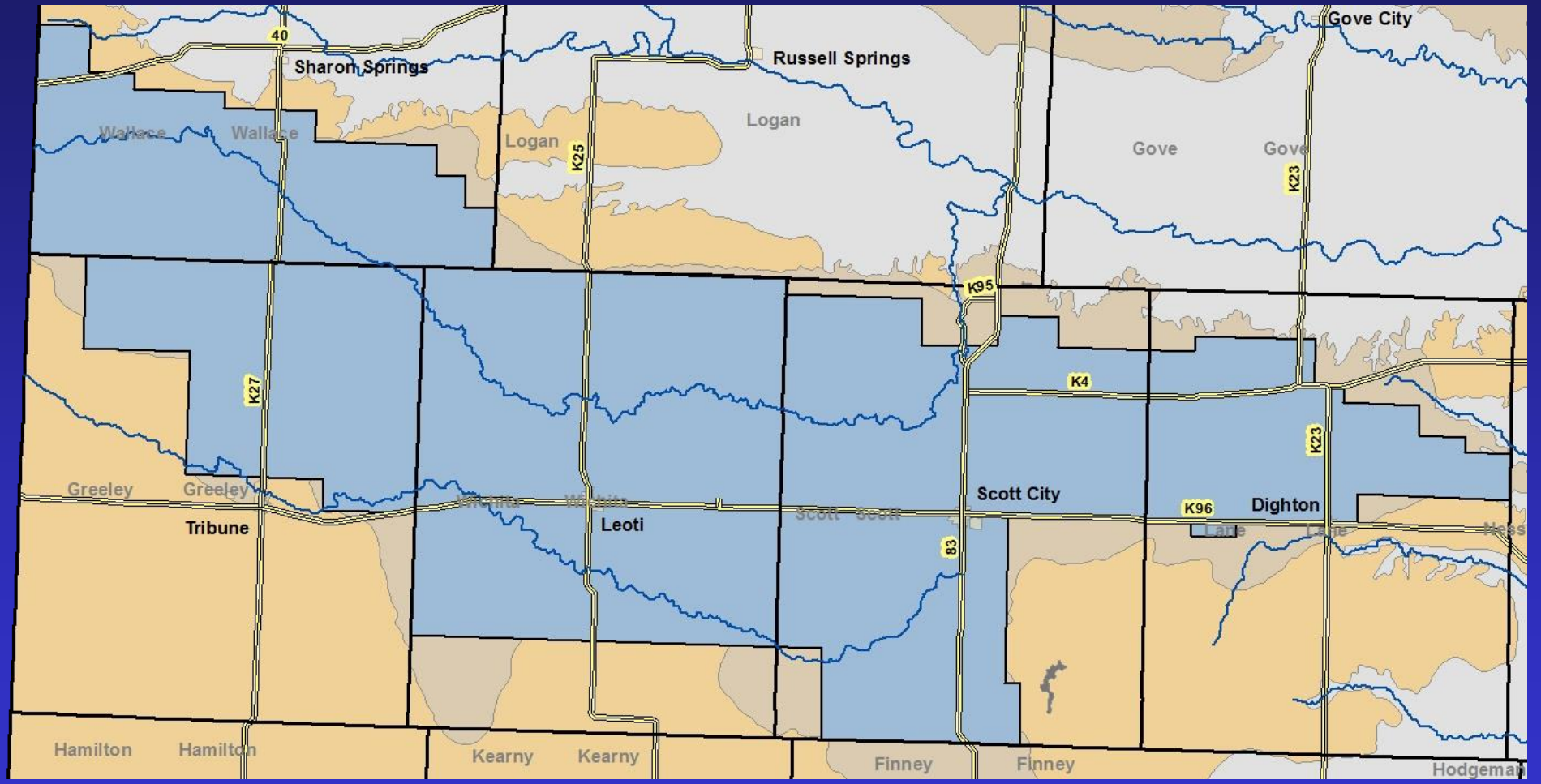


GMD #1 Municipal Buffer Zones

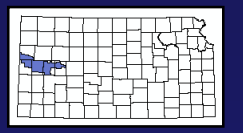


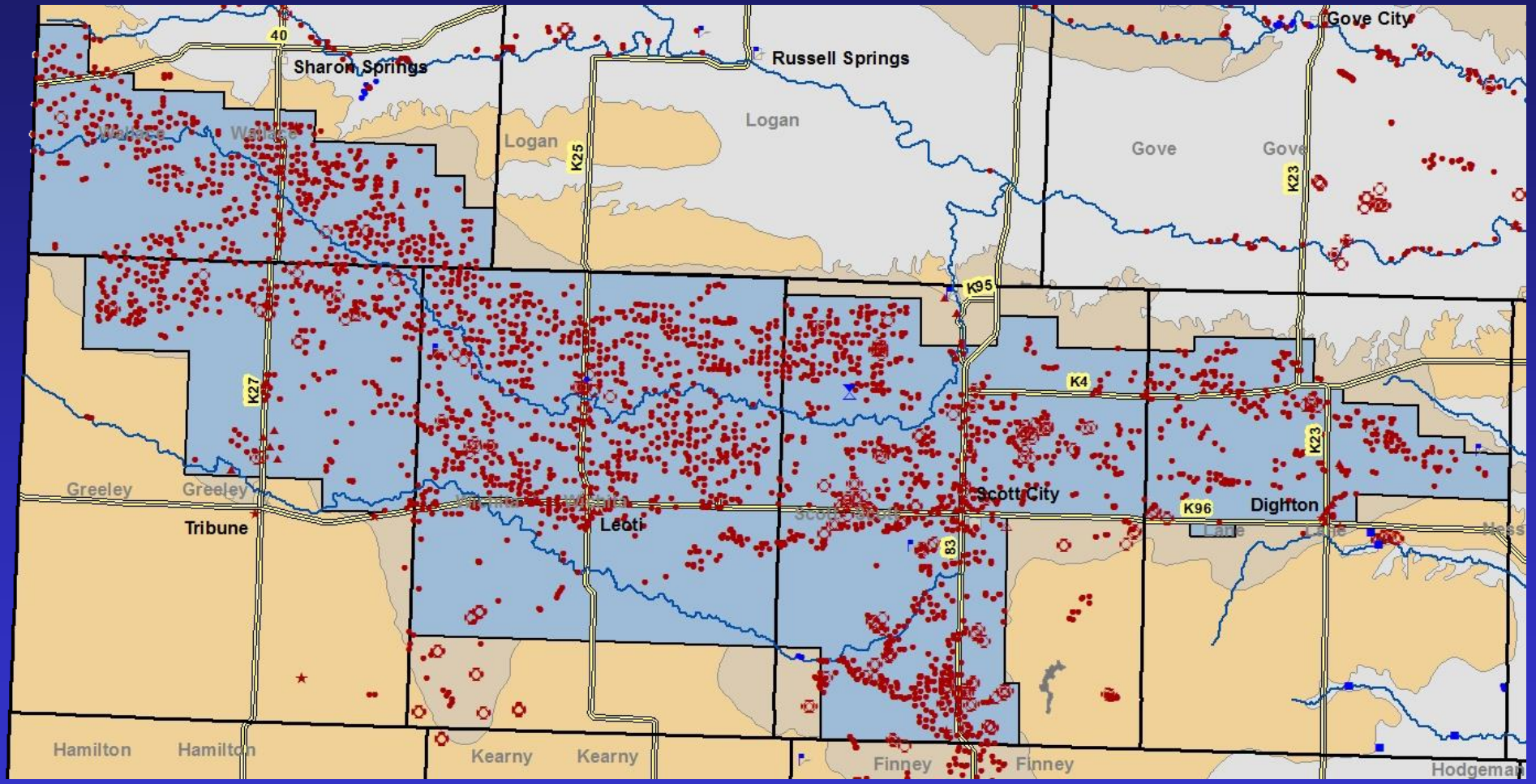


Western Kansas GMD #1 Subunit Criteria

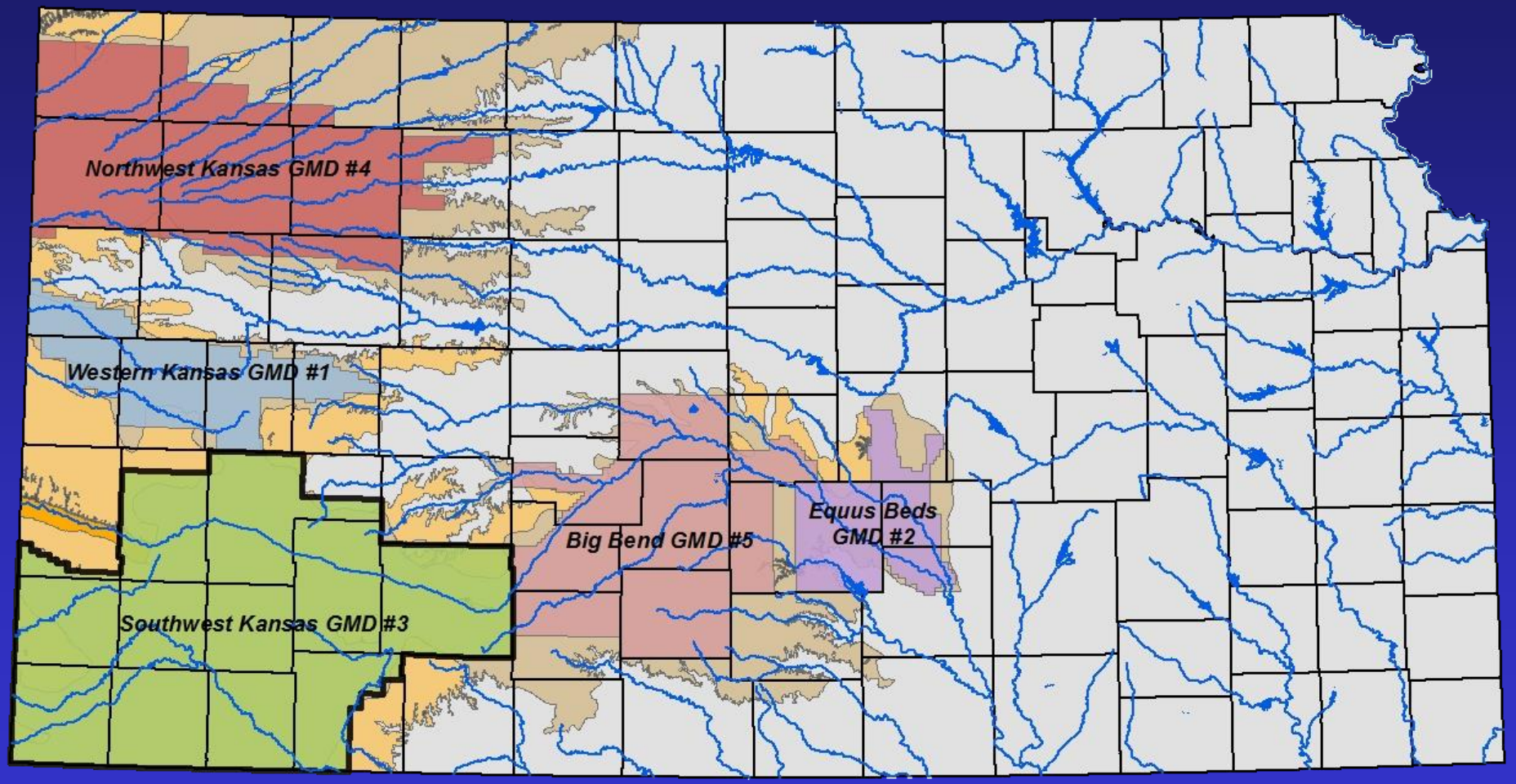


Western Kansas GMD #1 Subunit Criteria

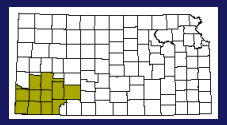




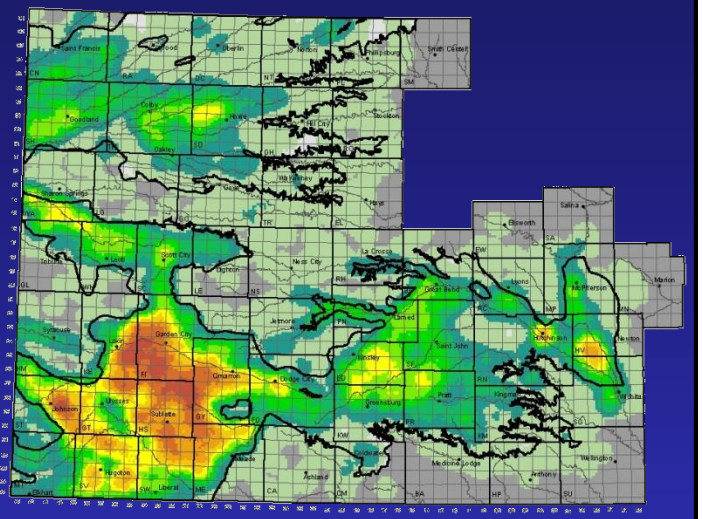
Southwest Kansas GMD #3



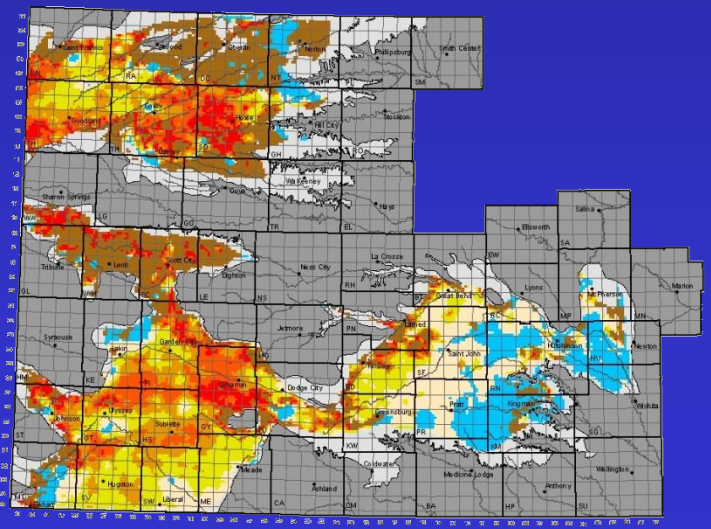
Southwest Kansas GMD #3 Subunit Criteria

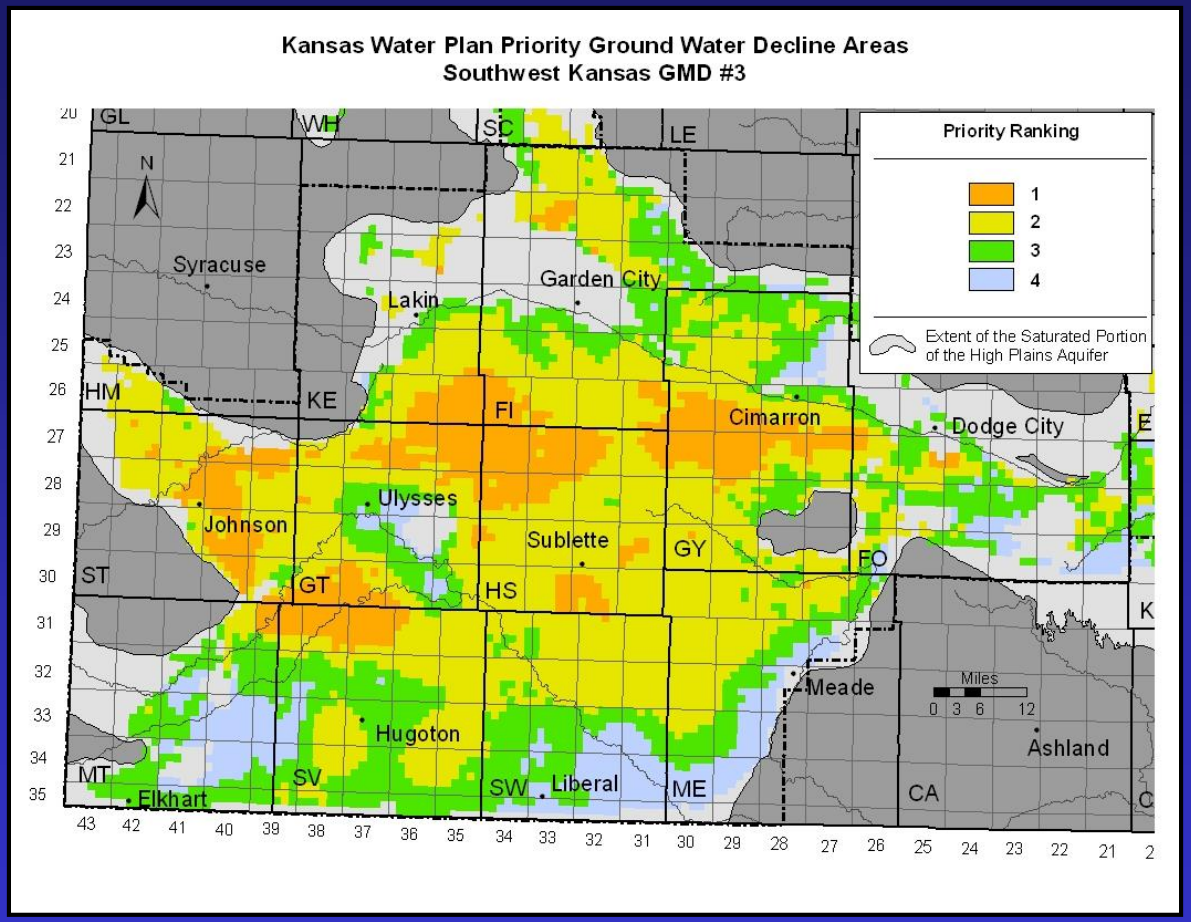


Water Use Density



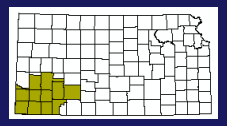
Estimated Usable Lifetime





Biggest Hang-up: **Boundary Lines**

GMD #3 Subunit Wishlist



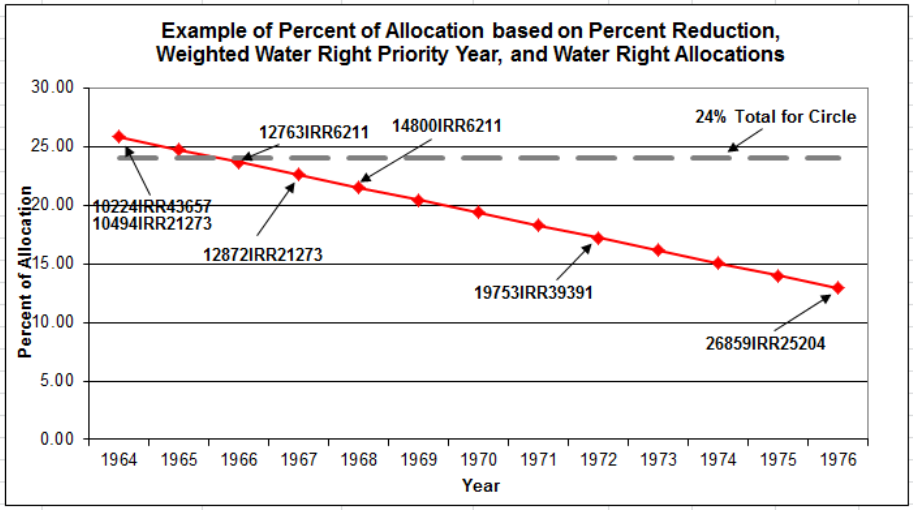
- Delineation of “Fuzzy” subunits

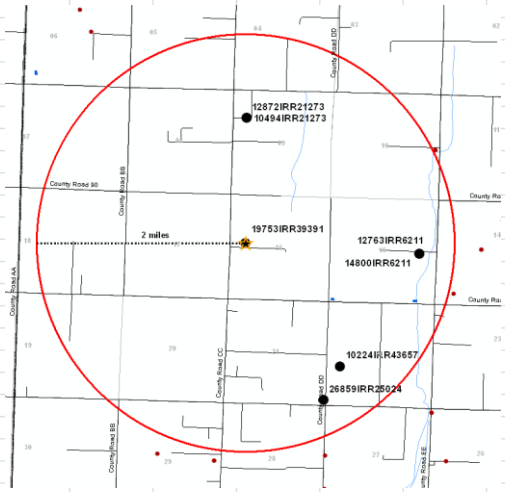
- Develop methodology to match ground-water extraction to some target volume
- Shared reductions by everyone (Vested water rights excluded)
- Honor water right priority dates (first in time, first in right)
  - A little more to Senior rights
  - A little less to Junior rights
- Focus on “Two-Mile” approach

The Geoff Bohling Solution…….

from_geoff.xls [Compatibility Mode] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Target (safe) yield:						670.21												
2	Target ratio of (% current FPDIV for most senior right) to (%current FPDIV for most junior right):						2		call this gamma										
3																			
4	Intercept of (%current FPDIV) vs.(Year-1964) line:						0.258129		Intercept = (target yield) / (weighted current yield)										
5	Slope of (%current FPDIV) vs. (Year-1964) line:						-0.01076		slope = intercept*(1-gamma)/(gamma*yn) where yn is the last value of (year - start), 12 in this case										
6																			
7																			
8		current FPDIV	Year	(Year - 1964)	weight*	FPDIV*weight		% current	new FPDIV										
9		835	1964	0	1.00	835.00		0.258	215.54										
10		882	1964	0	1.00	882.00		0.258	227.67										
11		705	1966	2	0.92	646.25		0.237	166.82										
12		56	1967	3	0.88	49.00		0.226	12.65										
13		0	1968	4	0.83	0.00		0.215	0.00										
14		175	1972	8	0.67	116.67		0.172	30.12										
15		135	1976	12	0.50	67.50		0.129	17.42										
16				**weighted current yield:**		2596.42			670.21	new total									
17																			
18	* weight: Just an interpolation from 1 at the beginning year (year 0) to 1/gamma at the last year, where gamma is the desired ratio of seniorest/juniorest (%current), 3 in this example																		



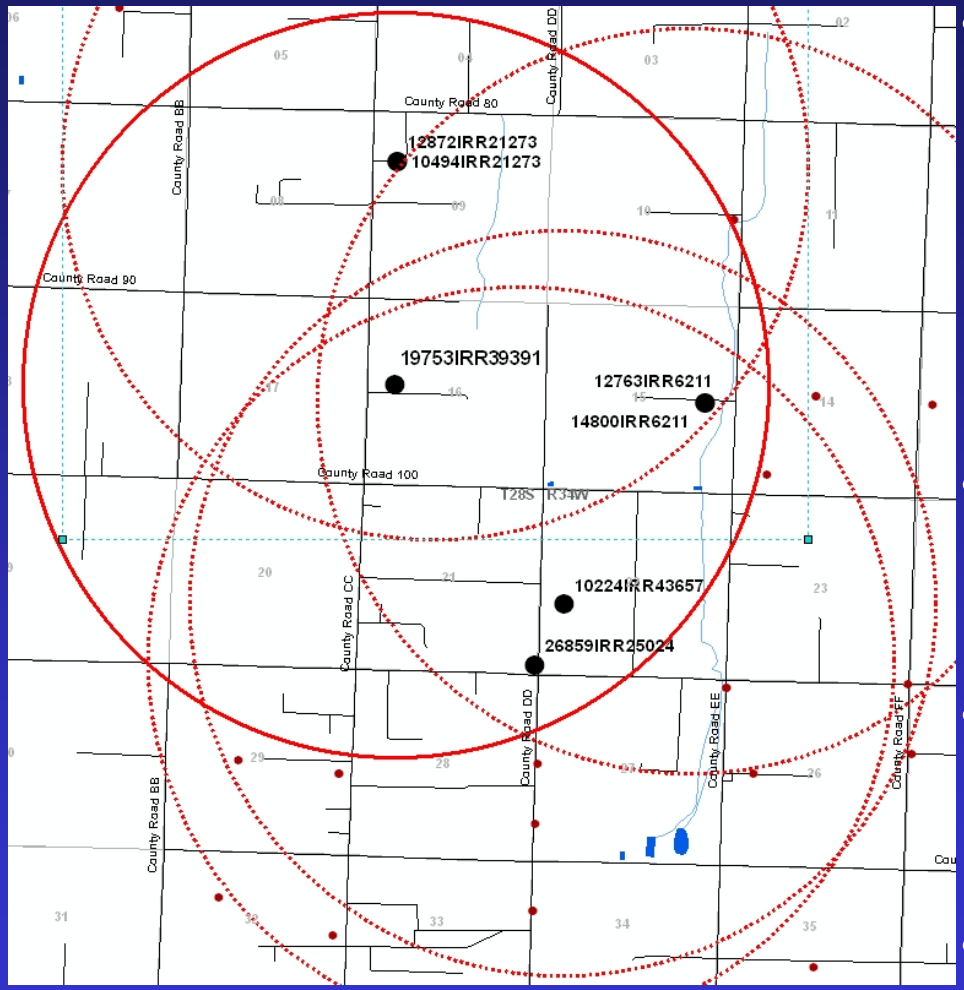


haskell_subset | Solution

Ready

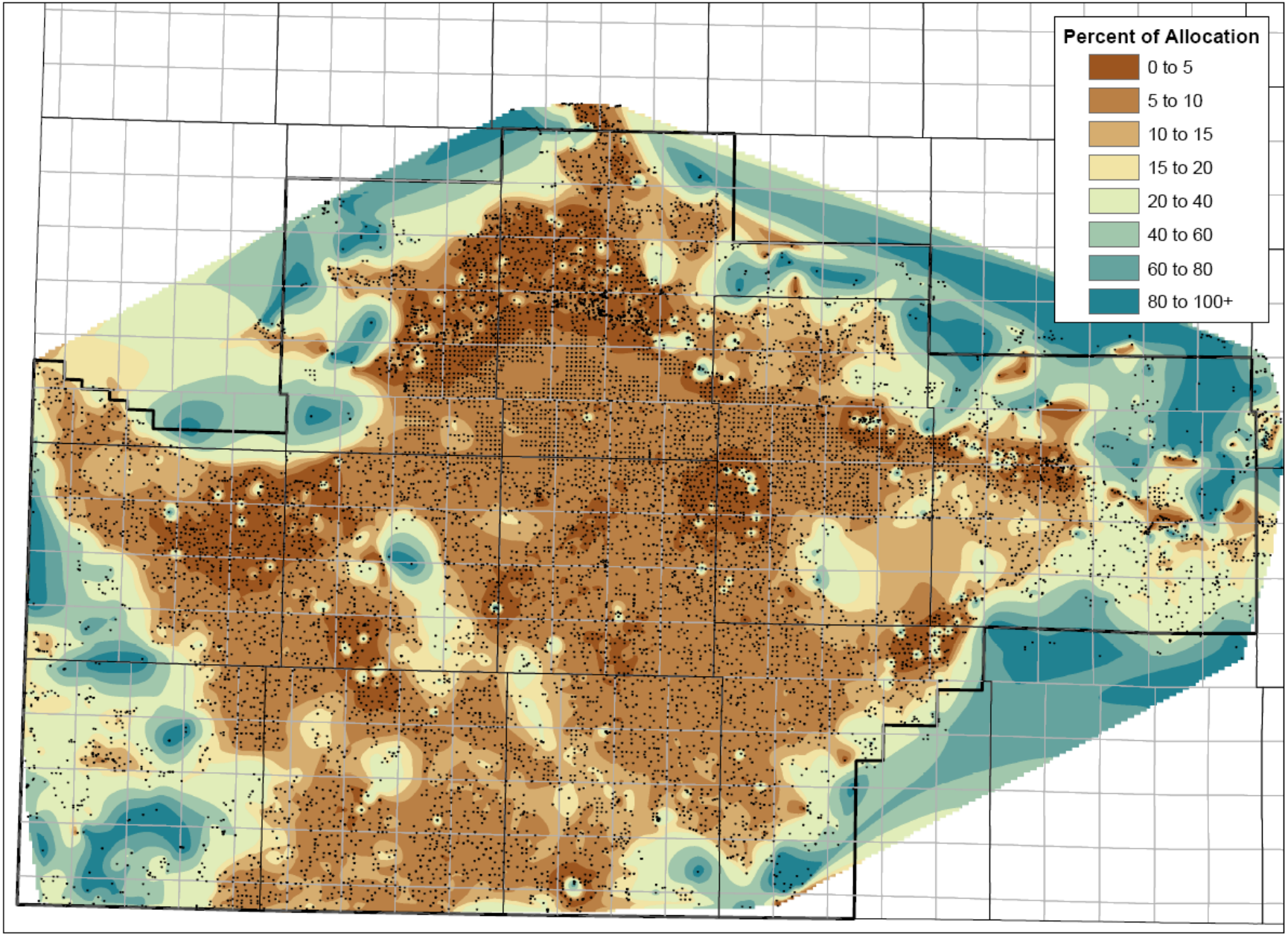
100%

Moving 2-Mile Circle Analysis

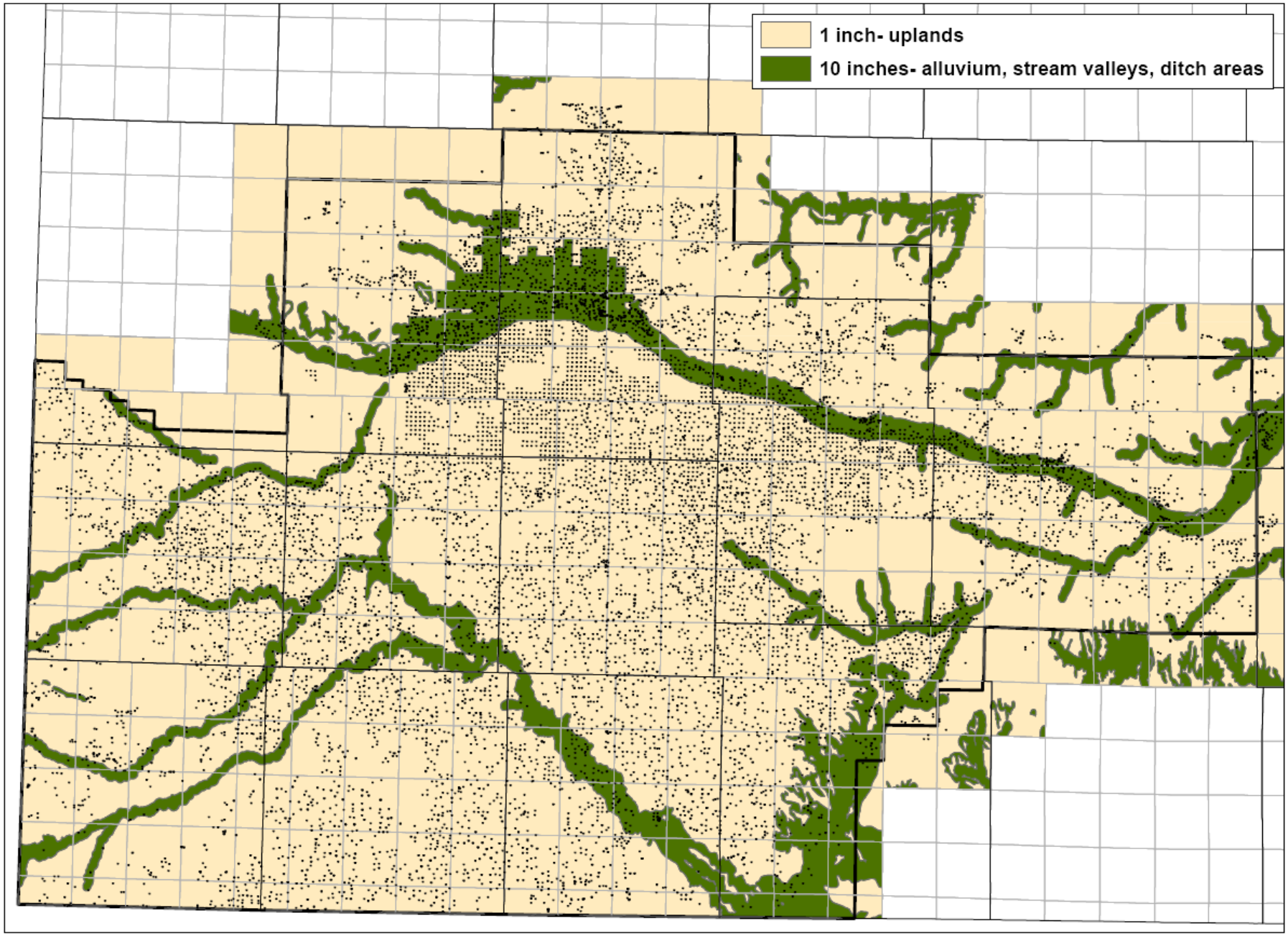


- Individual Water Rights will have different re-allocation amounts as relative priorities and budget targets change
- 19753IRR39391 is part of 7 individual circle reviews
- Percent of allocations ranges from 8.4% to 17.2%
- Average of 11.9%

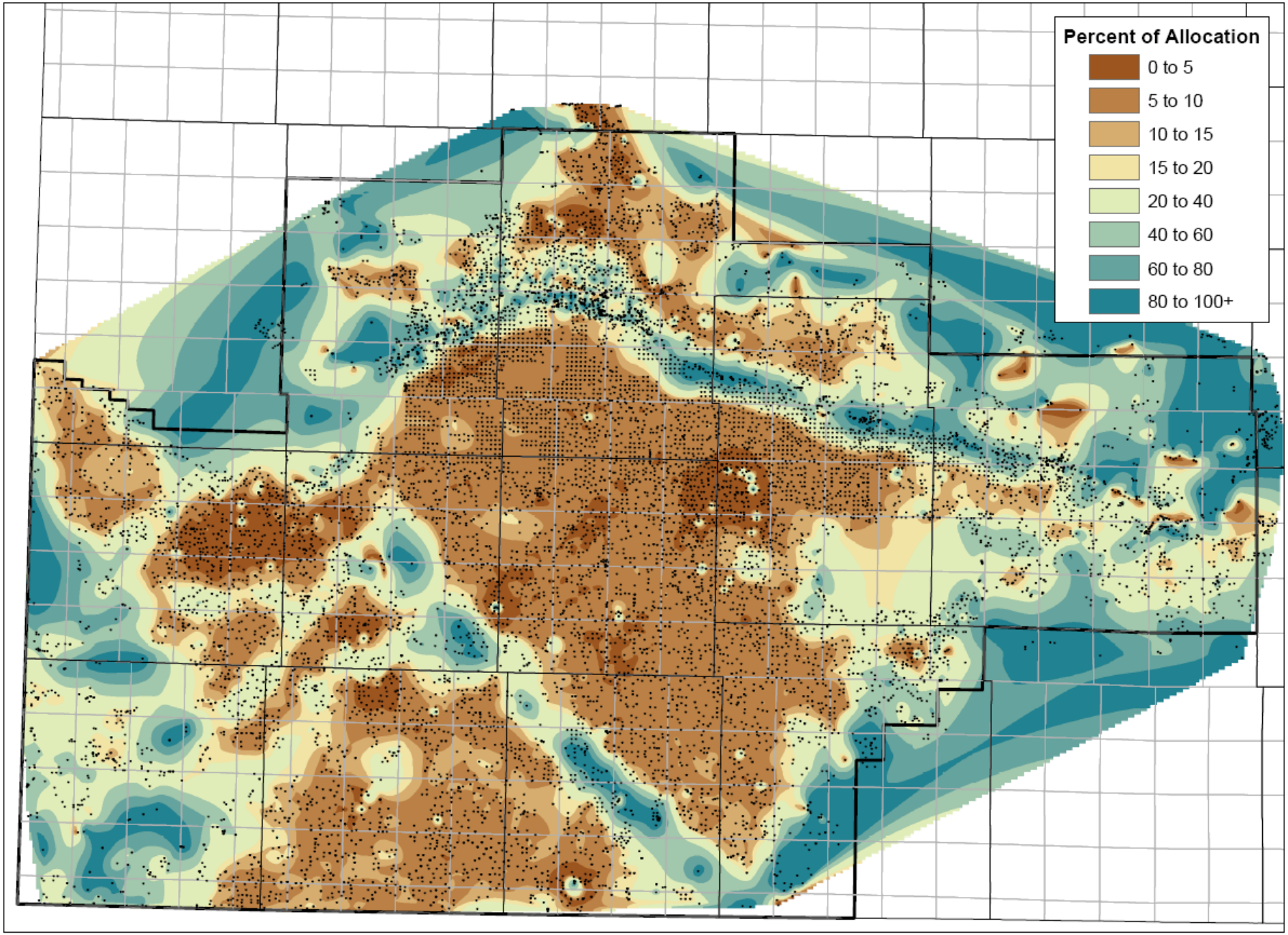
Average Percent of Current Allocation, by Point of Diversion, to Match Safe Yield Target
Recharge = 1 inch, Universal



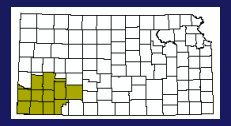
Recharge Zones



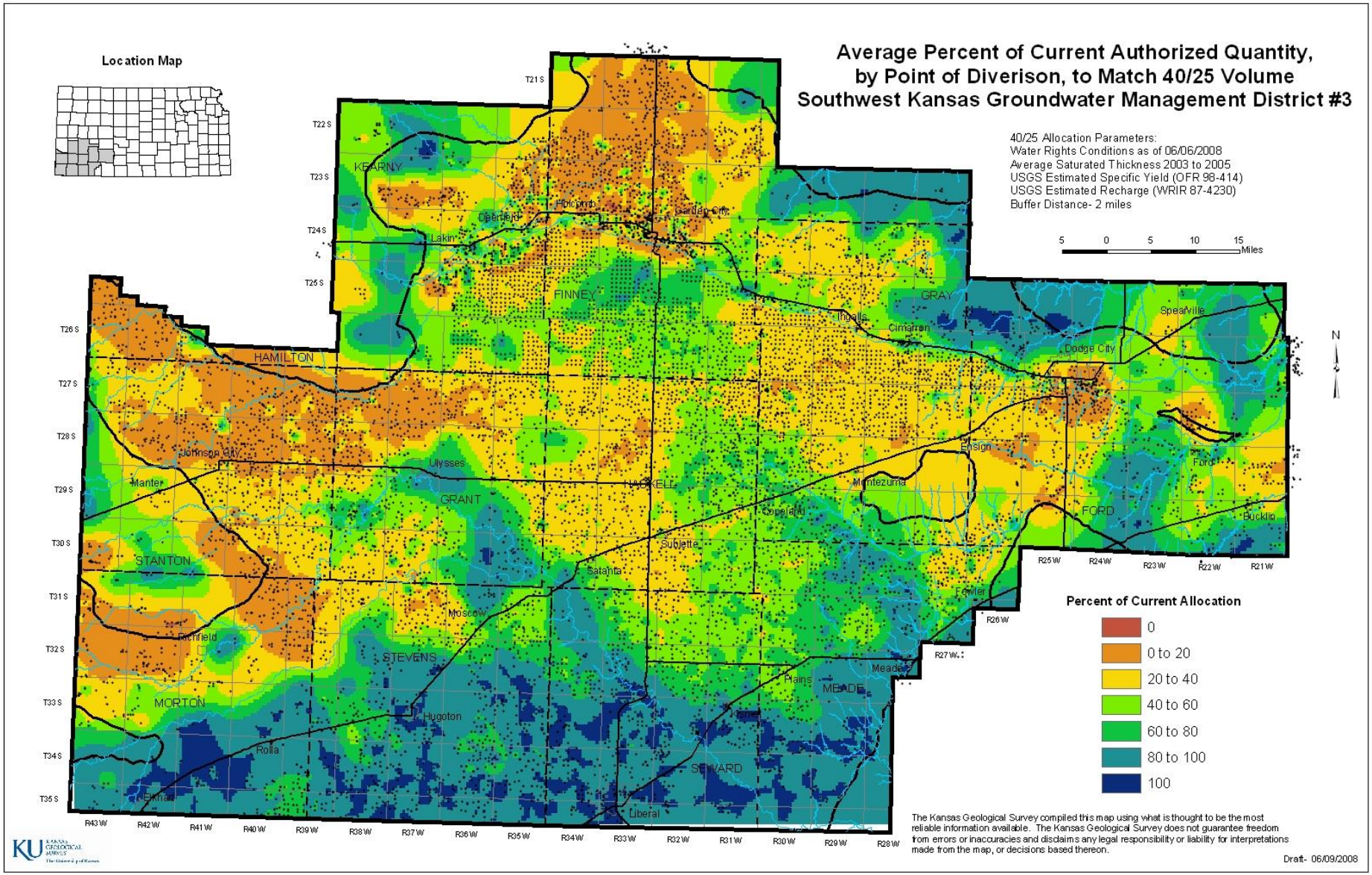
Average Percent of Current Allocation, by Point of Diversion, to Match Safe Yield Target
Recharge = 1 inch uplands, 10 inches alluvium and ditch areas



GMD3's 40/25 Rule



- Include budget allocation based on 40/25 Rule
  - 40% of storage used in 25 years
  - Involves other aquifer estimates
    - *Annual Recharge*
    - Saturated Thickness
    - Specific Yield
    - Time
  - Spatially Access Aquifer Parameters from the Section-Level Database


Location Map
Average Percent of Current Authorized Quantity,
by Point of Diverison, to Match 40/25 Volume
Southwest Kansas Groundwater Management District #3
40/25 Allocation Parameters:
Water Rights Conditions as of 06/06/2008
Average Saturated Thickness 2003 to 2005
USGS Estimated Specific Yield (OFR 98-414)
USGS Estimated Recharge (WRIR 87-4230)
Buffer Distance- 2 miles
5 0 5 10 15 Miles
N
KEARNY
FINNEY
GRAY
HAMILTON
GRANT
HASKELL
FORD
STANTON
STEVENS
MORTON
SEWARD
MEADE
Lakin
Deerfield
Holcomb
Garden City
Ingalls
Cimarron
Spearville
Dodge City
Ensign
Ford
Bucklin
Johnson City
Ulysses
Manter
Montezuma
Copeland
Sublette
Satanta
Fowler
Moscow
Richfield
Hugoton
Rolla
Elkhart
Plains
Meade
Liberal
T21 S
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T23 S
T24 S
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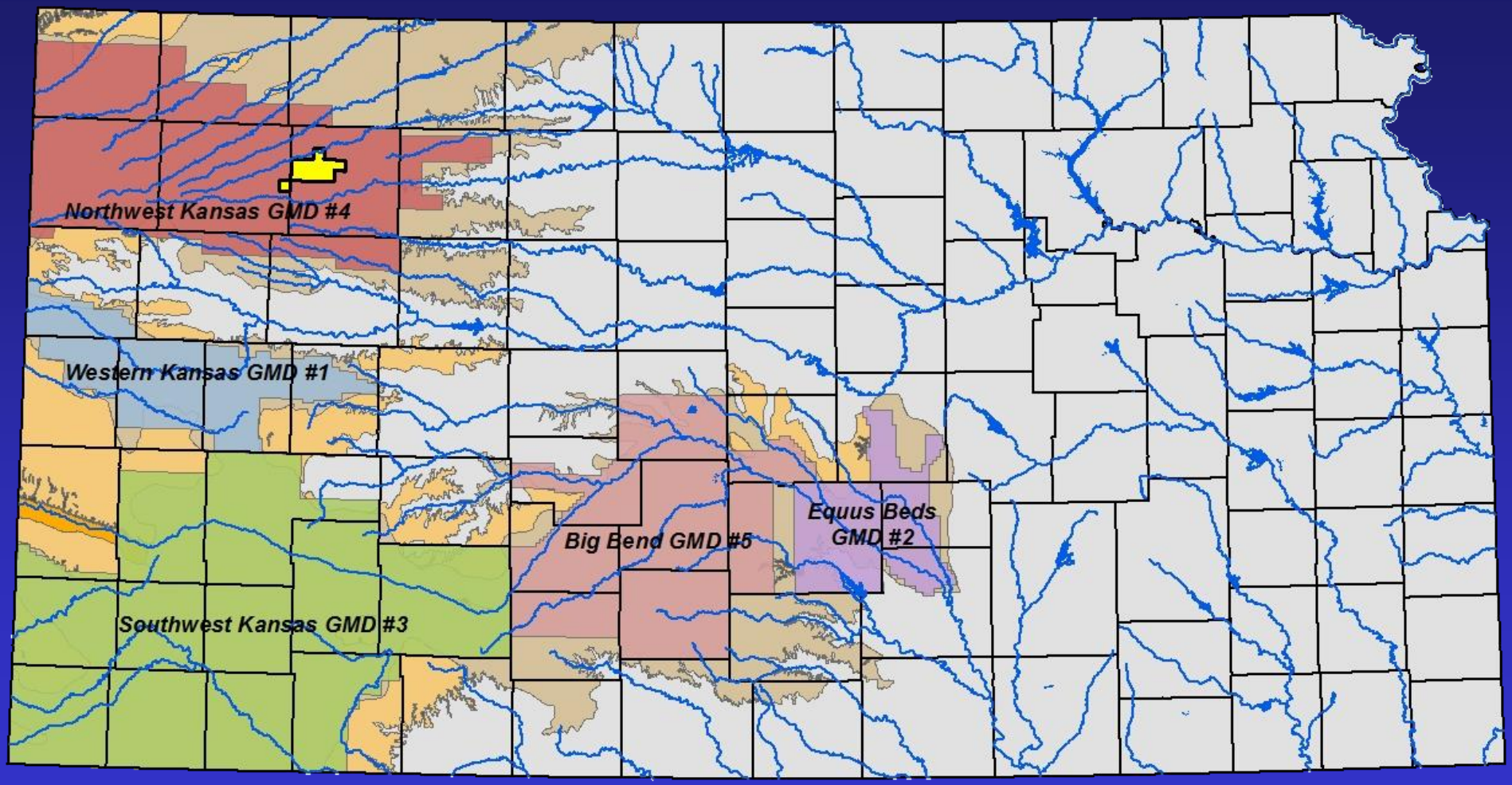
T27 S
T28 S
T29 S
T30 S
T31 S
T32 S
T33 S
T34 S
T35 S
R43 W
R42 W
R41 W
R40 W
R39 W
R38 W
R37 W
R36 W
R35 W
R34 W
R33 W
R32 W
R31 W
R30 W
R29 W
R28 W
R27 W
R26 W
R25 W
R24 W
R23 W
R22 W
R21 W
Percent of Current Allocation
0
0 to 20
20 to 40
40 to 60
60 to 80
80 to 100
100
The Kansas Geological Survey compiled this map using what is thought to be the most reliable information available. The Kansas Geological Survey does not guarantee freedom from errors or inaccuracies and disclaims any legal responsibility or liability for interpretations made from the map, or decisions based thereon.
Draft- 06/09/2008
KU Kansas Geological Survey

Groundwater Management Districts in Kansas



Questions????

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